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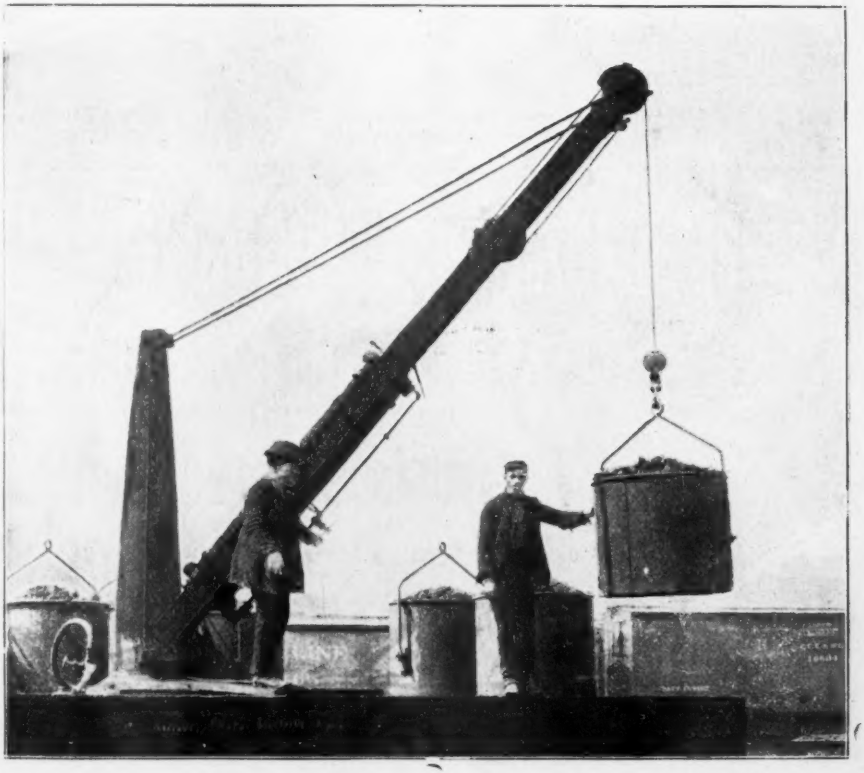
VOL. III. NEW YORK, DECEMBER, 1898. No. 10



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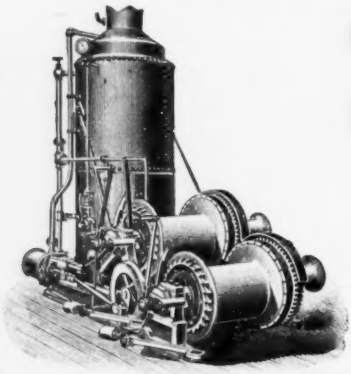

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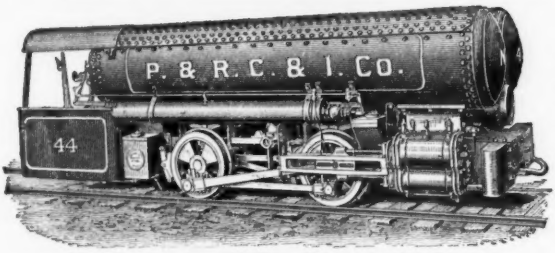

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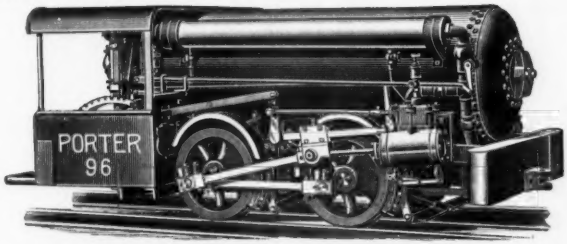

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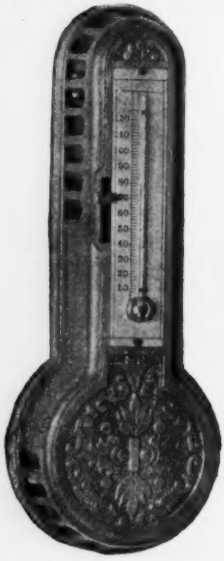

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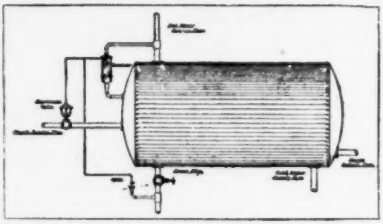

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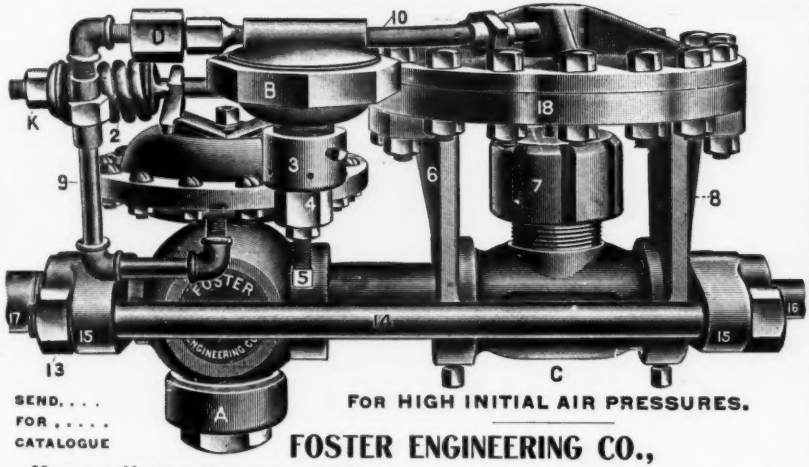

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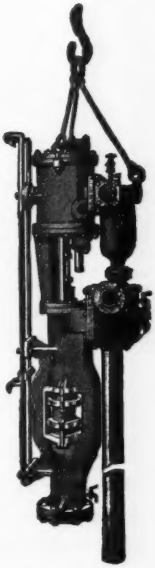

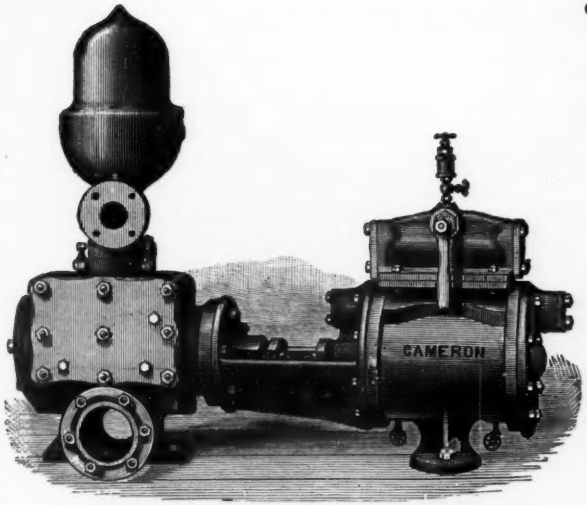

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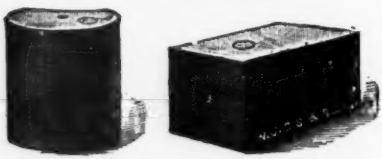

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VOL. III. DECEMBER, 1898. NO. 10.

The development in the method of hydraulic air compression, which has advanced materially within the past few years, has an interesting and important history. Our files are replete with information on this subject. The principles involved were first substantially shown in the "Trompe" or hydraulic blower or forge blast, which is a very simple, effective and strikingly ingenious method, and is understood to have been invented in Italy in 1640. The fundamental principle is that falling water is utilized for the compression and conveyance of air into suitable reservoirs in which it accumulates, and from which it is drawn and applied as a power. Under certain conditions the system of hydraulic air compression has advantages over mechanical forms, and these conditions arise when water power is present or adjacent. It can be used at any point where there is a sufficient fall to give the desired pressure. There are sources of loss inherent in the use of mechanism, such as the loss arising from the development of heat, friction, etc., that are largely obviated in the hydraulic compressing system.

The principles of the "Trompe" seem to pervade every patent or device that appears on this subject. The only fault in the early "Trompe" which has been overcome by the latter devices, is in low pressures and efficiency. In the "Trompe" blower forges only from 1½ to 4 ins. of water pressure were needed, and the "Trompe" remained as an air compressor suited to the wants of a forge at the low efficiency of from 10 to 15 per cent.

The "Trompe" shown in Fig. 1 is a large cistern, which is supplied with a constant stream of water and connected with another cistern vertically underneath it by means of wooden pipes, each measuring some 20 ft. in length. The length of these vertical pipes is not a constant quantity, but 20 ft. is a fair average. This lower cistern has two openings, one at the top, by which air gets away through the tuyere into the furnace, and another on one side near the bottom through which the water can get away. The openings of the vertical wooden pipes connecting the two cisterns are in the upper cistern partially closed by a kind of wooden funnel which causes the water to descend in the middle of the pipes instead of clinging to the sides, as might otherwise be the case. In the upright pipes, and a little below the upper cistern in an inclined direction, are several small openings, their inclination being downward. The flow of water into the upright pipes is regulated by plugs, one of which is shown. The water descending is directed into the center of the pipes by the wooden funnel. The descending water produces an "induced current" under the influence of which air is drawn into the pipes through the small inclined apertures, and passes on in considerable quantity along with the water down the pipes. In the lower cistern immediately below the vertical pipes is a board on which the water and air dash, and in doing so separate, the water going to the bottom of the cistern, and the air making its way through the tuyere into the furnace. This simple construction provides

for the compression of air at a very low pressure.

The first experiments leading to high air pressures were made by J. P. Frizell, of Boston, Mass., in 1877. An account of his invention, on which a patent was granted Jan. 29th, 1878, was published about that time. This patent seems to claim all of the essential features of the patents which have been granted since on similar methods. Patents have been also granted to C. H. Taylor, Adolph F. Du Faur, the late Col. Geo. E. Waring and others, covering the features practically the same as in the original "Trompe," with the arrangement and construction of parts designed to bring the efficiency of the system up to a practical point. The patent granted to Col. Waring adds a stroke to nature by using a blower or compressor for adding more air to the water descending the shaft.

Frizell's patent indicated a mode of transforming the power of a waterfall into compressed air by the arrangement suggested in Fig. 2. At a point above the dam a vertical shaft is sunk to a depth corresponding to the pressure required. For a pressure of 100 lbs. per square inch the clear depth would be 231 ft. Thence a horizontal tunnel extends to a point below the dam, meeting another vertical shaft which reaches the surface. The top of the tunnel is not exactly horizontal, but rises slightly from both ends toward the middle, at which point a chamber of sufficient capacity is excavated in the rock, whence the air is drawn off through a pipe. The whole forms thus an inverted siphon, through which the water flows with a velocity depending on the effective head. The length of the tunnel will be controlled by the necessity of placing the entrance to the chamber

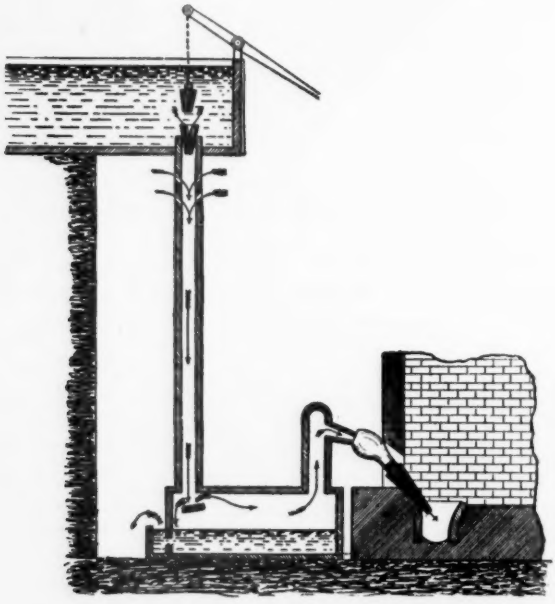


FIG. 1. THE "TROMPE," OR HYDRAULIC BLOWER.

far enough from the descending branch to admit of the complete escape of the air bubbles. The effective head will depend on the hydrostatic differences of ingress and egress of the water in the inverted siphon, and regulates the quantity of air carried by the descending branch. This can be regulated at will, and furnishes the means of controlling the velocity. Fig. 2 shows the method proposed for inducing the air bubbles into the descending column, though it is probable that a simpler method would disclose itself in the practical operation of the apparatus. The entrance to the vertical shaft is surrounded by a bulkhead of masonry. Over this bulkhead the water is led in a covered channel whose

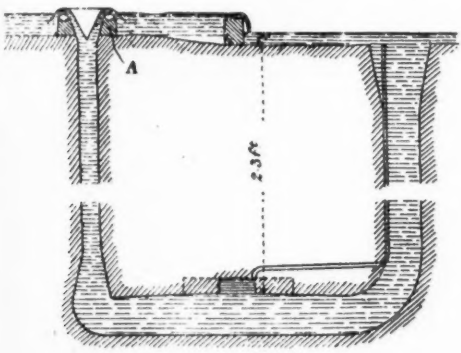


FIG. 2.

bottom rises a little above the highest level of the water in the pond, forming a siphon. The arched space below the siphon and above the measonry forms an accessible gallery, drained by a pipe which discharges below the dam. This gallery contains the cocks for regulating the admission of air. They are shown at A on the descending branch of the siphon channel, where its direction is nearly vertical. At this point the pressure within the siphon is less than that of the external air, and it will flow in through any opening.

The Frizell experiments cover broader ground than his patent claims. They suggest a good study of other forms for introducing air into the falling water tubes that may prove useful and lead to a higher efficiency. The efficiency in Frizell's early experiments was 26 per cent. Later by a larger apparatus he obtained an efficiency of 52 per cent. with a head of 5 feet.

The Taylor system has received considerable attention from the engineering press, and is familiar to the readers of "Compressed Air," as a description of the plant at Magog, Quebec, and at Ainsworth, B. C., has been given in these columns. The efficiency of the Taylor compressor is said to be 62 4-10 per cent. at 52 lbs. pressure, the compressor furnishing one cubic foot of free air compressed to 52 lbs. by a fall of 4 cubic feet of water 22 feet.

It is claimed that the air compressed by the hydraulic system has some advantages over air compressed in a cylinder, in that the air delivered will be drier than the external atmosphere and of the same temperature as the water which compresses it. This claim appears to be well taken. Persons without experience with compressed air naturally infer that air compressed hydraulically and in contact with water will be moist. In mechanical compression we have the "dry" and the "wet" system. The dry system is that where compression takes place without water contact, cooling being effected by jackets; and the wet system is that where cooling is effected by a spray of water introduced within the cylinder.

At times it has been noticed that air from the dry system has given more trouble from freezing than that from the wet system. This is due to the fact that in the latter when water is introduced in the cylinder in sufficient quantities and at low temperatures a condensation of

moisture takes place, the cold water acting like a condenser and absorbing some of the moisture that was in the air before it entered the compressor. This is strictly in keeping with the laws that govern condensation of moisture in atmospheric air. There are certain hydraulic systems of compression which add moisture to the air; among them is the hydraulic piston compressor. This is because the compression takes place rapidly. Heat is generated, and there are not sufficient points of contact of air and water to reduce the temperature of the air below the dew point. The "Trompe" system appears to be admirably adapted for furnishing dry air. The compression takes place slowly, and in air bubbles separated probably one from the other and distributed through the water column. It has been called the Pohle pump reversed, and we know that in pumping water by the Pohle system compressed air admitted at a higher temperature than that of the water is discharged at a lower temperature; in other words, the air is cool by thorough contact with water.

The "Trompe" system does not, as some suppose, require much head of water; on the contrary, a few feet of head are sufficient for ordinary purposes. What it requires is large water volume and a deep well. Nor is this system a competitor of the mechanical system of compression. The best engineering is that where a result is accomplished in the most economical manner. Where plenty of water exists and there is a chance to get a few feet of head, where the water does not cost much to use, and where a shaft or well may be sunk at reasonable expense, a "Trompe" air compressing system should be recommended. At the present time the Taylor system appears to be the most efficient for this purpose, and may be recommended as the best. Experience will probably still further improve the efficiency by increasing the volume of air compressed by a certain volume of water. A combination system might also in some cases be recommended. By this we mean a plant which compresses the air to low pressures hydraulically, the compressed air being then drawn into an air compressor and recompressed mechanically. We believe that there are large possibilities in this connection, as it is difficult by mechanical means to abstract the heat of compression during the early stages in the stroke of the machine. The temperature rises rapidly and in greater proportion to the pressure during the first half than during the second half of the stroke of an air compressor, and the percentage of increased power required to effect compression is thus greater. The "Trompe" system affords a means by which cold and dry comprssed air at low temperatures may be compressed by air compressors with economy. Such a combined plant need not require excessive depth of shaft or well, and should be recommended in places where sinking is difficult.

EXPERIMENTAL MECHANICS.

Method of Calculating and Recording the Results of the Experiments Made During the Supplementary Term.

BY PROF. D. S. JACOBUS, '84.

TABLE XVI.

TEST OF AIR COMPRESSOR.

1. Dimensions in inches and clearance.	Bore of air cylinder.....
	Bore of steam cylinder...
	Stroke of both pistons....
	Clearance of air cylinder in per cent.....
2. Revolutions per minute.	.....
3. Temperature of air in degrees Fahr.	Initial entering compressor..... .....
	Final in delivery pipe two feet from compressor...
4. Temperature of jacket water in degrees Fahr.	Initial..... .....
	Final..... .....

5. Temperature of water injected in degrees Fahr. { Initial..... Final when drawn from separator in delivery pipe..... .....
6. Weight of jacket water per minute in pounds.
7. Weight of water injected into air cylinder in pounds..... .....
8. Barometric pressure in inches of mercury.....
9. Indicated horse-power of air cylinder.....
10. Indicated horse-power of steam cylinder.....
11. Per cent. of indicated power of steam cylinder lost in friction. ... .
12. Value of γ in the equation $pv^{\gamma} =$ constant for the air compression curve.....
13. Weight of air compressed per minute calculated from the indicator card, in pounds.....

METHODS TO BE EMPLOYED IN CALCULATING THE RESULTS.

Items 1 to 8 contain the data observed during the test.

9. Same as item 13 of Engine Test, Table III, except that there is no factor of 2 in the numerator, because the compressor is single acting.

10. Same as item 13 of Engine Test, Table III.

11. $\left\{ \text{(Item 10—item 9)} \div \text{item 10} \right\} \times 100.$

12. An indicator card of the air compressor is shown in Fig 1.

If the temperature of the air had remained constant during compression then the curve of compression AB would be isothermal and the product pv of the pressure and the volume would be constant. The air is not, however, thoroughly cooled during compression and the equation becomes

$$p v^{\gamma} = C = \text{a constant.}$$

Lay off the lines of zero pressure and volume EF and ED in Fig. 1. If the pressure and volume at A be designated by the subscript a and that at B by the subscript b, we have

$$p_a v_a^{\gamma} = C,$$

and $$p_b v_b^{\gamma} = C.$$

From these equations we have

$$p_a v_a^{\gamma} = p_b v_b^{\gamma}, \text{ from which}$$

$$\log. p_a + \gamma \log. v_a = \log. p_b + \gamma \log. v_b$$

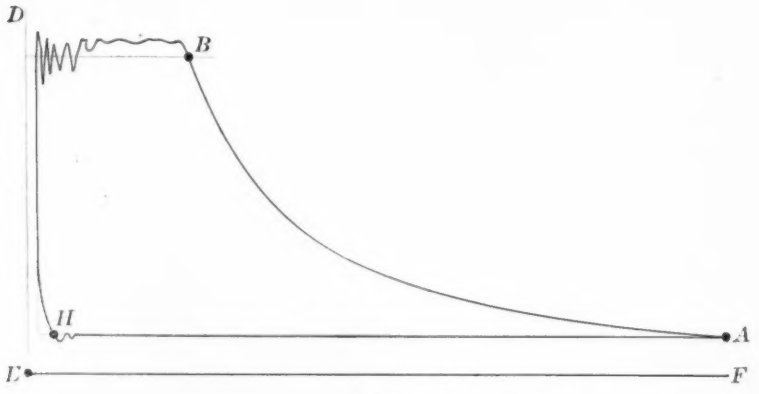


FIG. 1.

INDICATOR CARD OF THE AIR COMPRESSOR.

and $$\gamma = \log. \frac{p_b}{p_a} \div \log. \frac{v_a}{v_b} \quad . \quad . \quad . \quad (A)$$

The values of $\frac{p_b}{p_a}$, or the ratio of pressures, and the ratio of volumes $\frac{v_a}{v_b}$ will be the same no matter what scale is employed in measuring p_a, p_b, v_a, v_b; hence we may measure the distance on the indicator cards in inches and substitute in equation (A).

13. Determine the net volume swept through by the piston per revolution in cubic feet and multiply by the number of revolutions per minute, in order to determine the volume of air compressed per minute for full displacement; multiply this by the ratio of the distance *HA* to the length of the indicator card to allow for the effect of clearance. The volume of air compressed per minute multiplied by the density at the pressure *AF*, or that corresponding to the pressure of the atmosphere, will give the weight compressed per minute. To find the weight of one cubic foot of air at the pressure shown by the barometer and the temperature of the air on entering the compressor, make use of the table given on page 481 of "Kent's Mechanical Engineers' Pocket Book." The density corresponding to the temperature given in this table is multiplied by the factor,

$$b \div 30,$$

where b is the barometric pressure in inches of mercury (not corrected to 32° Fahr.), or more exactly by the factor,

$$b' \div 29.92,$$

where b' is the barometric pressure corrected to 32° Fahr.

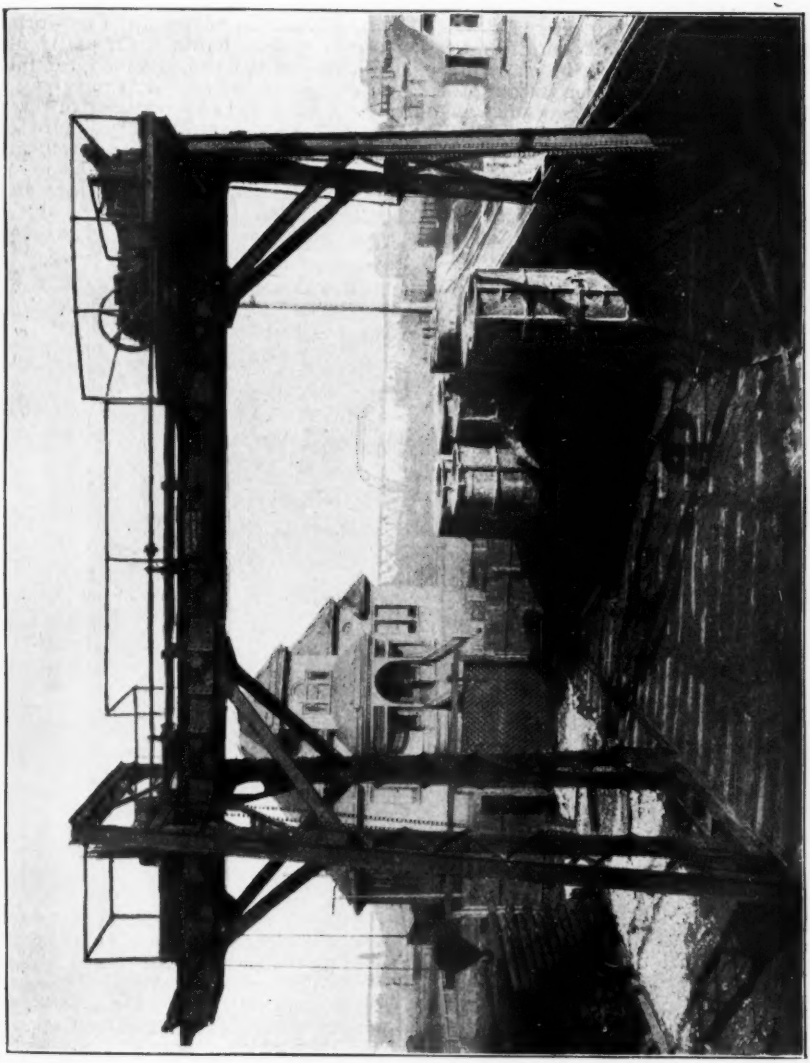
It is assumed in this computation that the temperature of the air in the cylinder, just before compression, is that of the external air. Usually this is not the case as the air is heated during admission and there is an increase in volume and consequently a loss of capacity due to this cause. In experiments made by Messrs. Gause and Post, Class of 91, this loss was found to be about 10 to 15 per cent.—*Stevens' Indicator.*

Pillar and Gantry Cranes Operated by Air Motors.

The Gantry crane, illustrated herewith, was made for the flask yard of Dennis Long & Company (manufacturers of cast iron water and gas pipe), Louisville, Ky. It has hoisting, longitudinal and cross-travel movements, all operated by independent compressed air motors. The capacity is five tons. The span center to center of track rails is 30 feet. The girders extend 10 feet beyond one end frame, which is open to allow the passage of the hook with the suspended load. The open space is 8 feet and has a full width for a height of 19 feet. The greatest lift of hook from the ground to the highest position is 22 feet. The extreme travel of the trolley on the girders is 34 feet 10 inches. The length of travel of the gantry on the surface tracks is about 250 feet. Air is furnished to this crane by means of flexible hose, which is carried on a large reel, not shown in cut. The operator is placed on top of the girders where the levers appear, in a position so that he may overlook the handling of the load. This crane has been very successful and has been in actual operation for over two years. The expensive trestle work is avoided in the use of this form of crane, and the extension longitudinally is limited only by the yard room at hand.

The pillar crane, shown on cover, is one of five (all duplicates) furnished the C., C., C. & St. L. R. R. (Big Four) for their coaling stations. They are used for both coaling locomotives and removing ashes from ash pits. The column is made of cast iron and the over all height is 8 feet 6 inches. The radius of the hook is 12 feet. The cylinder hoist is 12 inches in diameter and has 6 feet stroke. It is furnished with a quick acting valve, and loads are handled very quickly when necessary, also slowly, as may be desired, the operation being under perfect control. These cranes are capable of coaling a large freight locomotive in from ten to twelve minutes, using half-ton buckets.

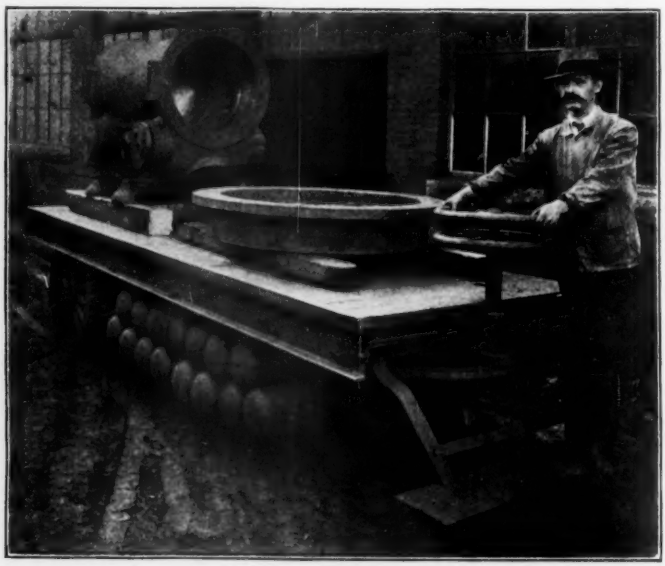
The Whiting Foundry Equipment Company, Harvey, Ill., who installed the above, has recently furnished a prominent steel manufacturing concern in the West with modified air hoists, to be used for charging billets into a reheating furnace, and also for raising table for mill. The pushers first mentioned are 14 inches in diameter and have a total stroke of 8 feet; are operated by air for both forward and reverse movements, being fitted with automatic attachment cutting off the supply when the limit of the stroke is reached at each end.



GANTRY CRANE OPERATED BY AIR MOTOR.

Compressed Air Truck.

Compressed air is the most compact, the lightest and the cheapest stored power outside of original fuels, and lends itself perhaps more readily to the horseless-vehicle than it has to the many other applications that has been made of it. Thus there might be some question as to compressed air cars having very decided advantages over the trolley or the cable car, they all run on a definite route and on a definite schedule, but for miscellaneous routes and miscellaneous traffic, freight or passenger, compressed air has as its only competitor the electric storage battery, over which it claims many advantages.



COMPRESSED AIR TRUCK.

Air compressed to 2500 and 3000 per square inch can be stored in a reasonable space on a truck, or other vehicle, and will carry the same 20 miles. The air is handled in exactly the same manner to that used on the compressed air cars, that is, it is let out from the reservoirs by an automatic reducing valve to the motors at a pressure of about 200 lbs. per square inch, its introduction to the motor being controlled by the ordinary throttle valve. The motor that is used for this purpose is of the ordinary Hoadley-Knight type, that is to say, it is an iron-clad motor, having all of its working parts in a closed iron basin partly filled with oil, so that no attention for lubrication is required. A simple wedge movement enables its operator to reverse the motor or control the point of cut-off. This is done by the lower hand wheel, shown in the cut. The upper hand wheel is used for steering purposes, it being connected to a segmented gear, attached to a single steering wheel. The throttle is controlled by a lever which is opened by the operator pressing his knee against it, and is closed by the action of a spring. The motor drives both the rear wheels through a compensation bevel gear arrangement, thus allowing it to turn in any direction. The truck when working under ordinary conditions consumes about 75 cu. ft. of air per mile. This would involve a cost per mile for power of less than one cent.

The compressed air truck in our illustration shows very forcibly the substan-

tial progress being made in the automobile field by the compressed air experts. Here is a truck which will handle ten tons of freight, and which occupies a space of 4 x 15 feet. It is guided and controlled with such ease that it is safe in the hands of the most ignorant operator. It is claimed that it will run about half a day on one charge of air, and will operate with a power cost not exceeding one cent a mile. The absence of all combustion of any kind insures the popularity of this form of stored power, and its great economy as compared with storage batteries places it in the lead of the possible powers for automobile work. For the race that must start in the near future for commercial supremacy in the automobile field, there are preparing in the mechanical world many radically different forms of motor vehicles. The race cannot be said to be started until actual competitive manufacturing has begun. Doubtless there will be found special fields available for several of the more successful types. There is the long distance work for vehicles traveling out many miles from the center, which of necessity cannot well be supplied with power from a central station. There is the light vehicle competing with the single horse rig, for which almost any form of motive power is suitable, but which can, perhaps, after all be best operated by the horse. There is, again, the omnibus field which, running as it does over limited and definite routes, can evidently be operated by a secondary charge from some central source of power, such as stored steam, compressed air or storage batteries. There is, further, the field of heavy trucking which amounts to many times more than all the rest of the work done by horses put together. This trucking being generally confined to the city streets, and to limited distances, and often to definite routes, is again a field open for secondary stored powers operating in conjunction with central stations, and it is an attempt to occupy this field that gave birth to the truck shown in our illustration. The attempt will be made to handle greater loads with more expedition and with the occupying of less space in the street than can be done with horses, and in these features the chief sources of economy are expected to be derived. Apart from the saving brought about by the substitution of mechanical power for animal power, the item of wages will be materially reduced. It is evident that with heavy loads moving at greater speeds the operator's time will be just so much economized.

The truck, as shown, is in daily use at the works of the American Wheelock Engine Co., Worcester. Mass., and fills a long-felt want in moving large castings and other bulky work from place to place without the need of cranes or hand trucks.

The air truck has been developed by the Pneumatic Carriage Co., and is being manufactured by the American Wheelock Engine Co., Worcester, Mass

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Compressed Air Applied to Traveling Motors by a New Method.

W. M. FARRAR.

While compressed air has shown itself a successful rival of electricity in a variety of problems in power transmission, in cases where motive power is to be supplied to traveling motors, the latter has heretofore completely distanced its rival. The great difficulty encountered

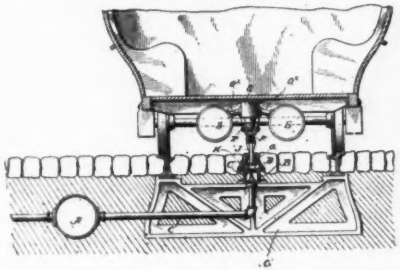


FIG. I.

in using compressed air for this purpose is that the air is necessarily carried on the inside of the pipe, and is therefore inaccessible except at the ends or outlets of the latter, while the electric conductor carries its fluid on its surface, from which

the current can be taken at any point along its whole length. This has been an insuperable objection to the use of compressed air at a moderate pressure as a great distances, as in the case of street cars or other traction. The result has been that while electricity has been apmotive power where the motor travels plied to this use in a way most favorable to economical results, the advocates of compressed air have been obliged to resort to high pressure reservoirs carried on the cars, greatly increasing the cost of power plants, occasioning delay in recharging and a great sacrifice in economy due to the extremely high pressures required.

In such an unequal contest it is not surprising that electricity has been the victor.

Even in cases where the motor is only required to travel over a limited space, as in traveling cranes and overhead hoists,

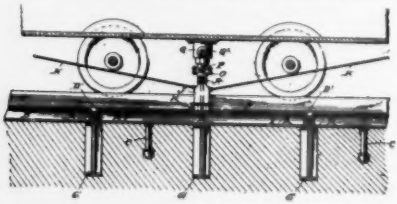


FIG. 2.

although compressed air is successfully used, the customary arrangement of flexible hose, supported by carriages, is at best crude and objectionable, occupying as it does much valuable space and in consequence limiting the travel of the motor to a portion of the working space.

The object of this article is to call attention to a recently invented method of applying compressed air to moving motors, which will obviate these difficulties, and will, it is confidently believed, place compressed air in a position to compete with its rival under similar conditions.

This method is exactly analogous to the "trolley system" for electricity; i. e., the line of travel and is drawn thence by the air is carried in conduits parallel to the motor, as required, continuously along the whole length of the line. The device by means of which this is accomplished was designed primarily with a view to its application to street car service, as the cuts indicate, but the principle may be equally as advantageously applied to traveling cranes and other motors of limited travel. In fact, after a description of the device, as applied in street railways, it will readily be seen, without any further explanation, how various other applications can be made.

The figures show the arrangement for a double track road. A (Fig. 1) represents the main conduit or supply pipe, which is laid between the two tracks and supplies air under pressure to cars on both tracks, and its size and consequent construction is, of course, to be determined by the requirements of each case, and depends upon the pressure carried, the number of cars, and the length of the line.

This air main is connected at intervals of about 6 feet with the auxiliary main B (Fig. 1), laid in the center of each track, by means of the pipe C.

These auxiliary mains are made of cast iron, and are rectangular boxes about 6 feet in length, and of the section shown in Figs. 1 and 3 being entirely closed, except for a slot C^1, formed in the top the entire length of the casting, into which is fitted a strip of rubber D (Fig. 3), the latter serving as a valve, and having inserted in it at intervals stiffening pieces E of iron, which render the valve rigid transversely but flexible longitudinally.

The strips D are bent downward at their ends, as indicated at D^1 (Fig. 5), and held fast at these points to the main D by a dove-tailed slot D^2, and they are also provided with springs F, which insure their return to the seat after being opened in any part of their length, as will be more fully explained.

Attached to the top of the main B are curbs G, of rolled steel, which form the slot at the surface of the street, and the mains and rails forming the tracks are shown resting on cast iron ties or foot blocks G^1, although this construction

might be modified by using wooden cross ties and wooden string pieces to raise the rails to the required level.

The trolley or connecting device consists of a brass box H sliding upon the upper surface of the main B and being

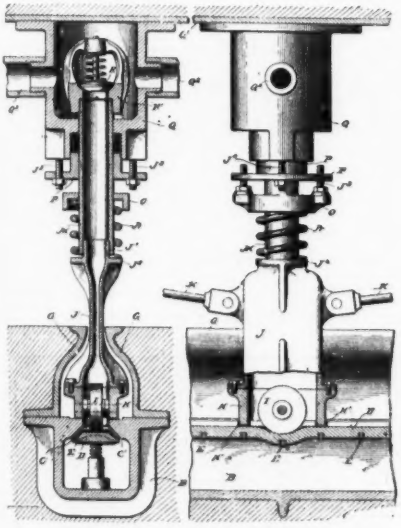


FIG. 3. FIG. 4.

where it comes in contact with the valve or the sides of the slot.

The sliding surfaces are to be lubricated by means of oil cups carried on the trolley.

The trolley box H is provided with a small wheel, or valve roll I, which rolls on the valve strip and presses it down immediately on coming in contact with it, as shown in Fig. 4, thus allowing the compressed air to pass into the box H. To the top of the latter is bolted a steel casting J, which is narrowed to pass through the slot and strengthened by

FIG. 5.

ribs, as shown. It is also provided with tie rods K to brace it longitudinally. The upper end of the casting J has an extension J^1, which is threaded into the tube M, and resting on its upper flange J^3 is a spring N, which may be adjusted by means of the screws J^3, which bear against the cap plate O and are threaded through the flange of the gland P.

The object of this spring is to compensate for any irregularities in the track and at the same time to overcome the upward pressure at the lower end of the trolley, insuring the latter's remaining firmly on the main B.

The gland P and the stuffing box Q, through which the tube M passes, are fastened to the frame of the car, and the stuffing box fits against a washer plate Q^1, which is placed into position after the check-valve R and its seat-casing R^1, which also serves as a collar on the tube M, have been placed in position.

The air is led from the stuffing box Q by means of the short pipes Q^2 to the reservoirs S, and these serve to equalize the pressure on the motor, and also act as a storage for a sufficient amount of air to start the car if it should be stopped directly on the crossing or turnout, where the trolley would be momentarily disconnected from the supply main.

The motor may be of any ordinary type, as determined by the conditions of the case.

The advantages claimed for this method of street car propulsion are:

First. Economy of first cost.

While the first cost of such a road would be greater than an overhead trolley line, it would compare favorably with the underground trolley and be much less than a cable road, while the cost of power plants would be much less than for any of the other systems. All that would be required would be a battery of boilers and a series of steam-driven air compressors, which are much cheaper than either electric or cable machinery, and require less space and consequently less ground and cheaper buildings.

Second. Economy of operating.

As compared with the underground trolley system, the efficiency of the power plants should be about the same, each consisting essentially of a steam plant and a transformer. The efficiency of the line, however, would be greatly in favor of the compressed air system, owing to the leakage from the underground electric conductor, which it is extremely difficult to insulate and the greater percentage of energy used to overcome resistance in the latter. As the cable system is now practically obsolete, it is useless to make any

comparison with that, although the advantage would be still greater.

Third. Miscellaneous advantages.

Among these may be mentioned simplicity of machinery, as compared with any electric system, both in the power house or on the car, requiring less technical knowledge to operate or repair, less danger of breakage, in the first place, and less cost to repair when broken. This system also provides the means always at hand for an efficient and quick-acting brake, which is an appliance greatly provided with a soft rubber packing H' needed for street car service if high speed is to be attained.

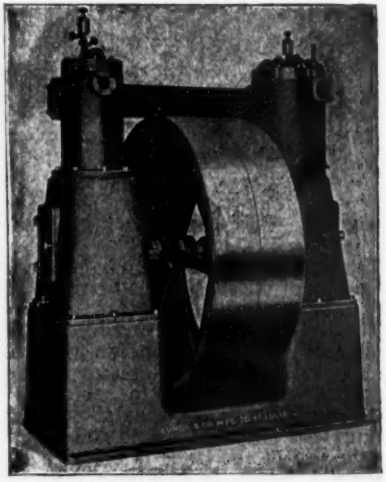
This device, as can be readily seen, can be easily applied to traveling cranes and similar machines, with a saving of space and convenience in operating, but it has another application in which it far surpasses any other system, viz.: underground railways, because motors operating under this system not only would not vitiate the atmosphere of the tunnel, but would furnish a positive and costless method of ventilation by means of the exhaust, infusing fresh air at all points along the line, and just in the proportion required. This system could be applied to tunnels of existing railways, with the object of ventilation, by using the cylinders of the present locomotives as motors and applying the compressed air while in the tunnel by providing the apparatus with a mechanism for dropping it when nearing the tunnel in a somewhat similar manner to that now employed for taking water from track tanks. When the apparatus was dropped the steam would of course be shut off and the damper closed so as to prevent any smoke, steam or gas from escaping, and the air used as a motive power until the farther end of the tunnel was reached, when the apparatus could be raised and steam used again.

This application could hardly be expected, however, to appeal very forcibly to railway management, as it would entail considerable expense without any immediate visible return, but the vast army of commuters who are compelled to pass twice daily through any of the tunnels leading out of New York, with cars crowded, a temperature of 100 F. inside, and all windows per force tightly closed, would shower blessings on the head of anyone who would devise some means of relief.

There are many other minor applications of this device, but the limits of this article preclude anything further at this time. Its object will be attained if it will convince someone of the value of this invention to the cause of compressed air.

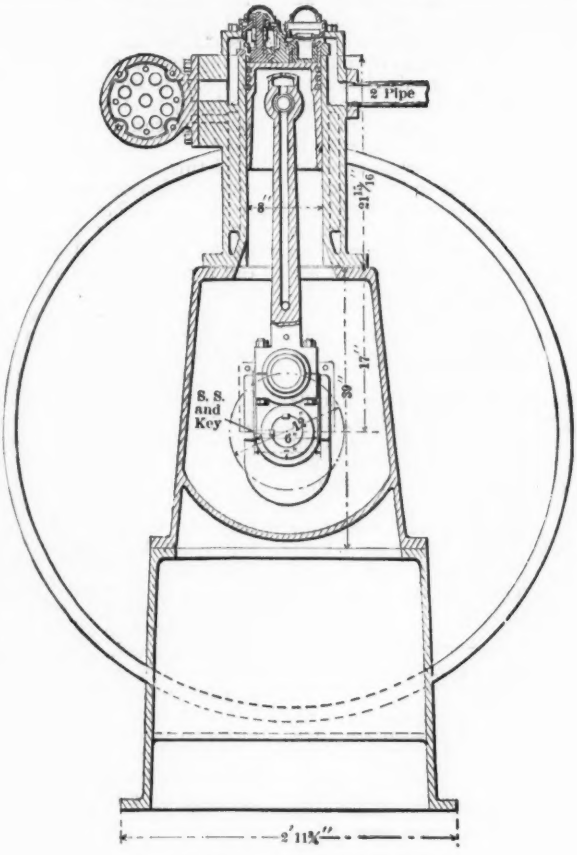
Belt-Driven Air Compressor for Shop Service.

The half-tone and accompanying drawings illustrate an air compressor especially designed for the constant maintenance of a working supply of compressed air in machine shops, boiler shops, foundries and similar places where it is the growing practice to employ air-operated tools and facilities. The compressor is of the belt-driven type, with tight and loose pulleys, for easy stopping and starting. It is designed to be usually kept constantly running, a pressure governor automatically operating a run-around which stops the operation of compression when the pressure rises above a given point, and allows it to resume again when the pressure falls. One of the special features of this machine is that the governing action does not stop the flywheel, which is always ready to respond to duty. The compression is in two stages, with an efficient intercooler between the cylinders. The diameter of the cylinders, each single



BELT-DRIVEN COMPRESSOR.

acting, are respectively 13 inches and 8 inches, with a stroke of 12 inches, and the free air capacity at 120 revolutions per minute is 100 cubic feet of free air, the permissible pressure being 110 pounds gauge, although 75 or 80 pounds is the more common practice. The pulleys are feet of free air per minute. As will be seen, the compressor is entirely inclosed, but the working parts are easily accessible. By the hinged door at each side the connecting rods, cranks and main bearings are reached; all the valves are in the cylinder heads, each valve having its own



SIDE VIEW OF BELT-COMPRESSOR.

60 inches x 10¼ inches, and the belt may be led off in any direction most convenient, the revolution being in either direction.

The same style machine is also built in size 16 inches in diameter, 10 inches diameter, 16 inches stroke. Flywheel 66 inches diameter, 15 inches face, having a capacity at 120 revolutions of 200 cubic

cap and being independently removable. In the half-tone the high-pressure cylinder is nearest the observer, and the air is discharged at the side flange, to which the pipe to the receiver or line is to be attached. The free air enters at the side flange of the other cylinder, and if for any reason desirable an air pipe from the outside of the building or elsewhere may be

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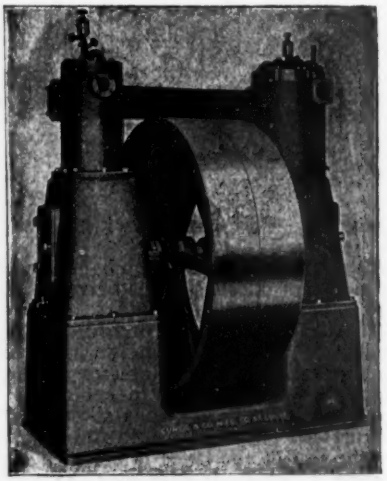
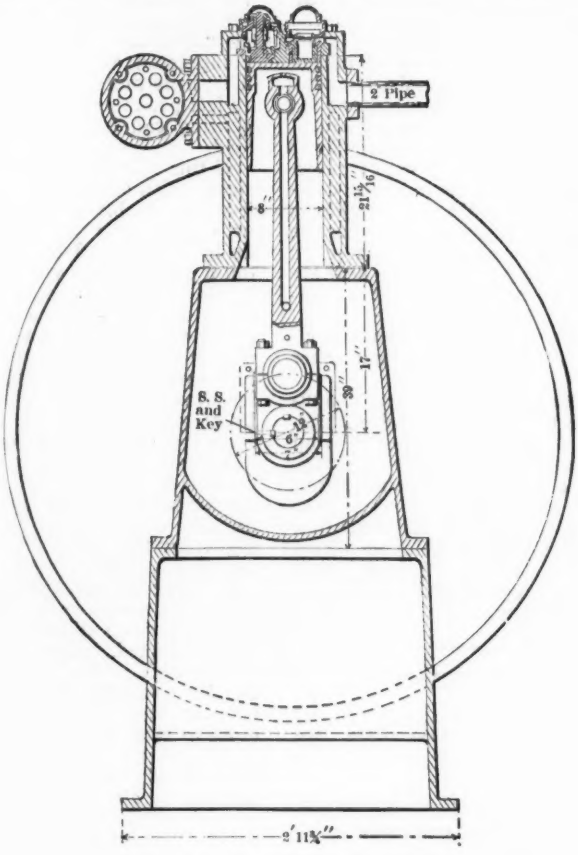


BELT-DRIVEN COMPRESSOR.

acting, are respectively 13 inches and 8 inches, with a stroke of 12 inches, and the free air capacity at 120 revolutions per minute is 100 cubic feet of free air, the permissible pressure being 110 pounds gauge, although 75 or 80 pounds is the more common practice. The pulleys are feet of free air per minute. As will be seen, the compressor is entirely inclosed, but the working parts are easily accessible. By the hinged door at each side the connecting rods, cranks and main bearings are reached; all the valves are in the cylinder heads, each valve having its own



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connected. The provision for the lubrication of every working part is deserving of notice. There are chain oilers on the main journals and a pressure grease cup takes care of the upper pin. The base of the compressor is 6 feet x 3 feet and the total height is 7 feet. The drawings give very clear information as to the construction and operation of this compressor.

The design of this compressor is admirable, giving many points of advantage over other styles; the single-acting cylinders give 80 per cent. more cooling surface than the ordinary single cylinder, double-acting, increasing the efficiency in proportion, and doing away with troublesome stuffing boxes. This immense cooling surface is thoroughly water-jacketed, and partitions so arranged that there is a forced circulation of cooling water, so that all parts subject to excessive heat are kept cool. The advantage gained is readily understood.

This style of compressor is nearly double in weight of the same size of any other make.

These machines are now being manufactured in both single and double stage, either belt or steam driven, of sizes from 25 to 200 cubic feet of free air per minute, by the Curtis & Company Manufacturing Company, St. Louis, Mo.

We are also pleased to call attention to the very handsome catalogue which this concern has just issued, and it will be sent to all interested parties by applying to the manufacturers.

COMMUNICATIONS.

Under this heading will be published inquiries addressed to the Editor of COMPRESSED AIR. We wish to encourage our readers in the practice of making inquiries and expressing opinions.

We request that the rules governing such correspondence will be observed, viz., all communications should be written on one side of the paper only; they should be short and to the point.

Editor "Compressed Air":

Dear Sir—Have been a reader of "Compressed Air" for over a year, and while I am very much interested in air power and hope to see its adoption in many places where it now is not, I am not in a position to put any of it to good use except in the way of keeping up a fresh supply for respiration purposes.

At one time I was quite familiar with clearing up railroad wrecks and I remember the slow process of the hand derrick for hoisting and removing the debris. On a busy road where both main tracks are blocked this always means a big delay.

Some time ago I happened into the foundry of J. J. Radley & Company, New York, and found there a little motor of the reversible and direct-acting piston type attached to the gearing of an old-fashioned hand derrick and operated by compressed air for lifting heavy loads. This little motor easily lifts 8,000 pounds 10 feet per minute, and by changes in the gearing can be made to lift almost any load.

If this motor was attached to the derricks which are erected on wrecking cars, it would enable wrecking crews to clear up wrecks very much quicker than they do by hand, and I believe it would figure out a considerable saving per wreck. The whole expense of putting in the appliances would not exceed $200; that would buy the motor and an air receiver. Every engine pulling a wrecking car has an air brake pump and can supply sufficient air for all requirements. The receiver should be of good capacity so that rapid work could be done without danger of diminishing the air pressure at a time when most needed. The receiver can be located on the derrick car or under it. From the time the engine is coupled to the wrecking train the work of compressing air may begin, and long before it reaches the wreck a good supply may be laid up. The intervals between each lift are usually long enough to allow the supply of air to be replenished. Should the air fail at any time, which is not probable, the derrick can be operated by hand as usual. It takes at least four men and sometimes more to raise an ordinary coal "jimmy," and it takes several minutes to wind up by hand what can be done in a very few seconds by air. One man to handle the valve is all that is required and the time saved in raising ten coal "jimmies" would be at least an hour.

I believe some of the larger railroad systems have steam cranes for wrecking purposes, but I know there are many roads which still use only the hand derricks. The work of attaching these motors is not difficult, and to the master mechanics who read your interesting journal I submit my plan, if you will be kind enough to publish it.

A SUBSCRIBER.

Harlem, Nov. 8th, 1898.

ALPHABETICAL LIST OF PNEUMATIC INVENTIONS.

For which United States patents have been granted. Prepared for COMPRESSED AIR from official records by GRAFTON L. MCGILL.

APPLIANCE.	NAME OF INVENTOR.	DATE OF ISSUE.	NO.
Air Brake	Andrews	June 26, 1888	385,224
"	Brockway et al	Sept. 19, 1882	264,617
"	Bass	Feb. 17, 1885	312,245
"	"	Feb. 22, 1887	358,142
"	Boluss	May 15, 1888	382,749
"	"	Oct. 29, 1889	414,138
"	"	Feb. 19, 1889	398,310
"	"	Sept. 2, 1890	435,791
"	Burbank et al	May 20, 1890	428,299
"	Barnes et al	Oct. 27, 1891	462,193
"	Bayley	Feb. 17, 1891	Reissue 11,145
"	"	Nov. 6, 1894	528,712
"	Bothwell	July 21, 1891	456,247
"	Beery	May 12, 1891	452,334
"	"	Nov. 1, 1892	485,365
"	Barber	April 4, 1893	494,772
"	Brown	May 22, 1894	520,391
"	Borbridge et al	Sept. 18, 1894	526,178
"	Bishop	Dec. 25, 1894	531,584
"	Beemer	July 28, 1896	564,863
"	Brookmire	April 21, 1896	558,670
"	Boyden	May 25, 1897	583,278
"	"	May 25, 1897	583,279
"	Buckpitt	Sept. 14, 1897	589,957
"	Bragg et al	Nov. 9, 1897	593,531
"	Bentley	Jan. 5, 1897	574,656
"	Champion	Feb. 3, 1874	147,225
"	Chadwick	August 1, 1876	180,460
"	Carpenter	March 22, 1887	359,953
"	"	Feb. 28, 1888	378,657
"	"	July 26, 1892	479,736
"	Collins	April 2, 1889	400,638
"	"	April 2, 1889	400,639
"	Coates	Feb. 2, 1892	467,920
"	"	Feb. 2, 1892	467,921
"	Corporan	Oct. 4, 1892	483,802
"	Clark	July 10, 1894	522,825
"	Clifton	Dec. 18, 1894	531,100
"	Clarke	Nov. 12, 1895	549,703
"	Conness	June 4, 1895	540,539
"	"	August 3, 1897	587,519
"	Christensen	Feb. 26, 1895	534,813
"	Custer	Jan. 21, 1896	553,481
"	"	Jan. 21, 1896	553,482
"	Corrington	Nov. 30, 1897	594,464
"	Catlett	Jan. 25, 1898	598,814
"	Clowry	June 7, 1898	605,394
"	Dwelly	Nov. 28, 1865	51,158
"	Dickson	Oct. 7, 1884	306,140
"	Dixon	May 1, 1888	382,031
"	"	Sept. 18, 1888	389,643
"	"	April 30, 1889	402,418

ALPHABETICAL LIST OF PNEUMATIC INVENTIONS.—*Cont.*

APPLIANCE.	NAME OF INVENTOR.	DATE OF ISSUE.	NO.
Air Brake	Dixon	Oct. 1, 1889	412,168
"	"	Dec. 31, 1889	418,506
"	Daellenbach	Nov. 12, 1889	415,162
"	"	Dec. 2, 1890	442,019
"	Dodd	Nov. 10, 1891	462,966
"	Duval	Nov. 22, 1892	486,703
"	Dunn	April 19, 1892	473,302
"	Dean	Dec. 19, 1893	511,071
"	Duval	Dec. 12, 1893	510,635
"	"	Dec. 12, 1893	510,870
"	Dunn	Jan. 10, 1893	489,527
"	"	Sept. 17, 1895	546,510
"	"	Jan. 28, 1896	553,517
"	"	Sept. 1, 1896	567,024
"	"	Feb. 23, 1897	577,425

PATENTS GRANTED OCT., 1898.

Specially prepared for COMPRESSED AIR from the Patent Office files by Grafton L. McGill, Washington, D. C.

611,629—Pneumatic Motor. F. W. Hedgeland, Chicago, Assignor to W. W. Kimball Company, same place.

The power pneumatics are arranged around a common centre in opposite pairs. Valves control each pair of said pneumatics, the shifting of such valves being effected by valve-controlled pneumatic devices. The last mentioned valves of each pair of opposite pneumatics have their stems coupled together and extended so as to be operated in both directions by the moving sides of the pneumatics.

612,149—Locomotive Air Brake. W. P. Alter, Dennison, Ohio.

The brake cylinder, triple valve and auxiliary reservoir are employed in connection with an engineer's valve connected thereto, the valve being provided with an additional port in its seat opening through the casing. This opening is connected by a pipe with the exhaust port of the triple valve. The rotary or valve portion of the engineer's valve is provided with additional cavities, while a pressure-reducing valve is introduced between the triple valve and brake cylinder.

612,778—Automatic Air Brake. W. G. MacLaughlin, Kansas City, Mo., Assignor to the MacLaughlin Manufacturing Company.

The object of this invention is to provide apparatus by means of which brakes may be actuated by fluid forced through the apparatus by means controlled by power other than that of the fluid which it forces through the apparatus. The mechanism for applying or releasing the brakes performs the former function when the fluid is moved in one direction there through, and the latter when it is moved in the opposite direction. Means are provided for maintaining fluid under pressure through the actuating mechanism and for moving such fluid there through in either direction whereby the brakes may be applied or released without releasing any portion of the fluid from the brake mechanism.

613,142—Air Brake. W. T. Hamar, Atlanta, Ga.

The piston of the triple valve has therein a double-seating valve yielding inwardly from the pressure on the trainpipe side and opening with a partial range of movement to let air pass, and closing with an extreme range of movement to close the air passage.

When calculating the capacity of an air compressor remember that the suction pressure will never be as high as that of the atmosphere, varying inversely as the altitude and the pressure being reduced by reason of the friction of the air entering the cylinder through the small openings; the greater the piston speed of the compressor the greater the reduction of pressure of the air that enters.

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00	capacity	$\frac{3}{16}$ in	weight	4	lbs.
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0 extra	"	$\frac{3}{4}$ in	"	15	lbs.
1	"	1 in	"	35	lbs.
1 extra	"	$1\frac{1}{2}$ in	"	49	lbs.

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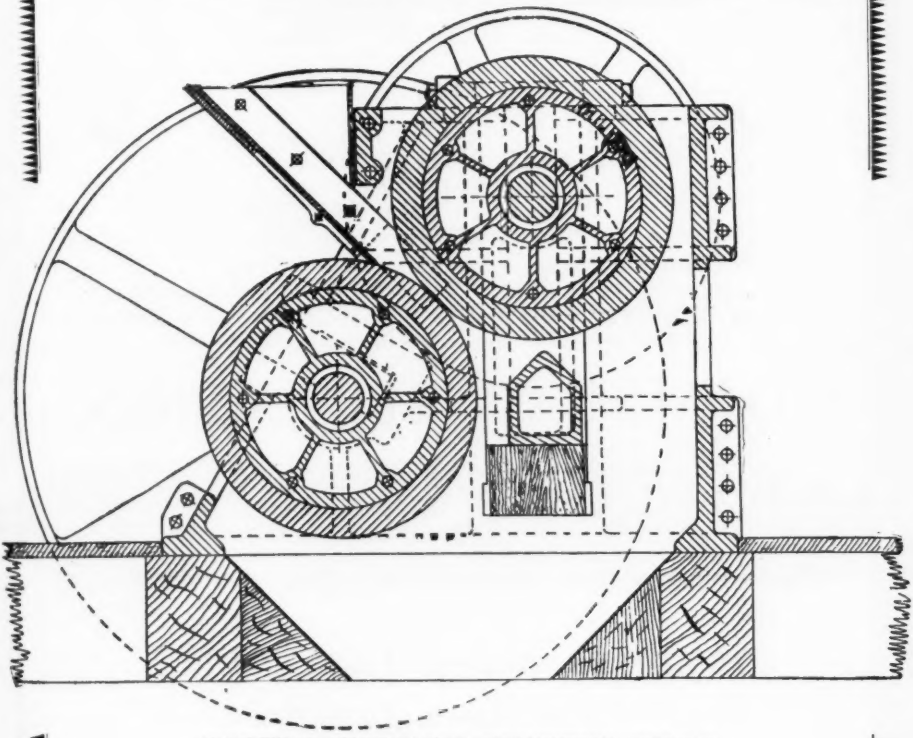

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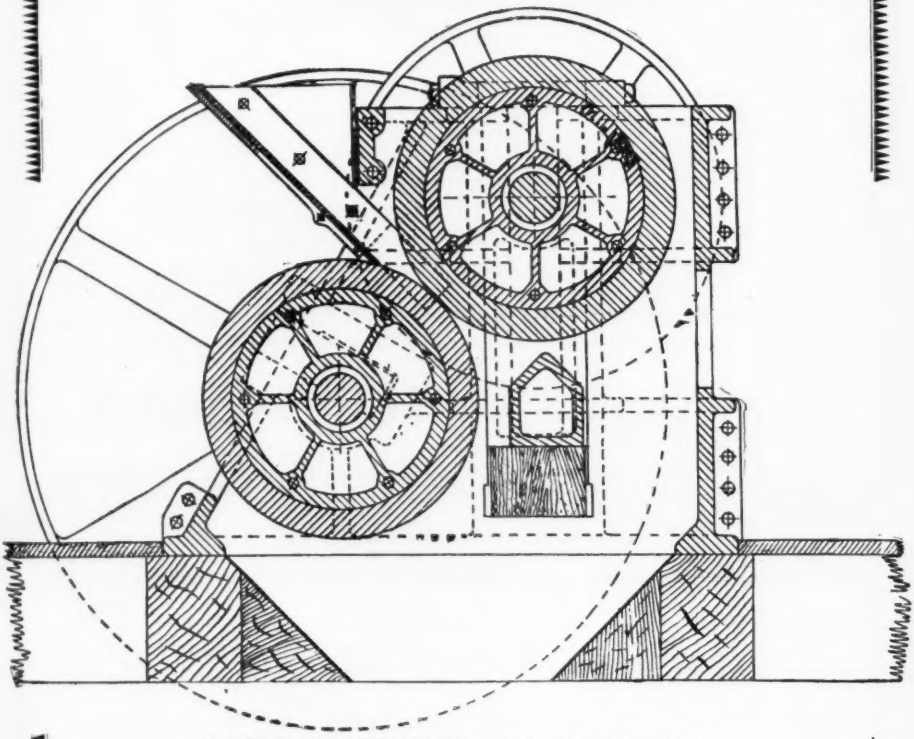

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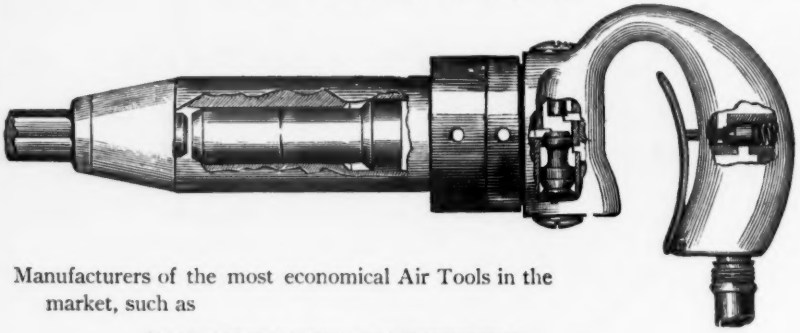

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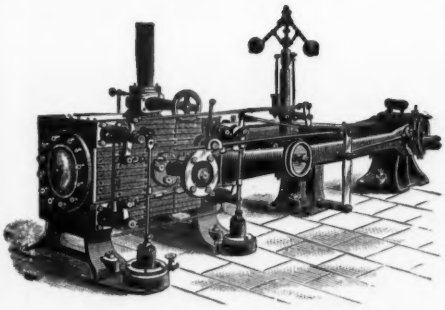

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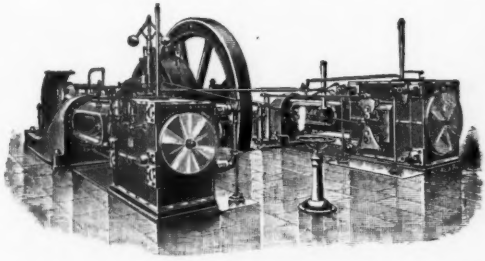

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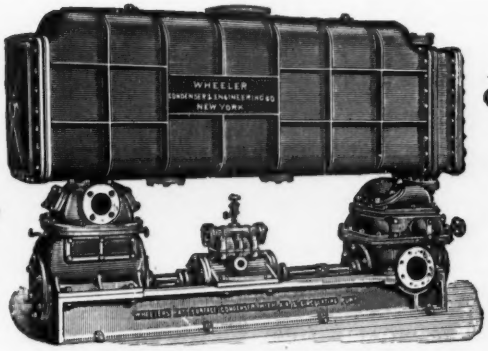

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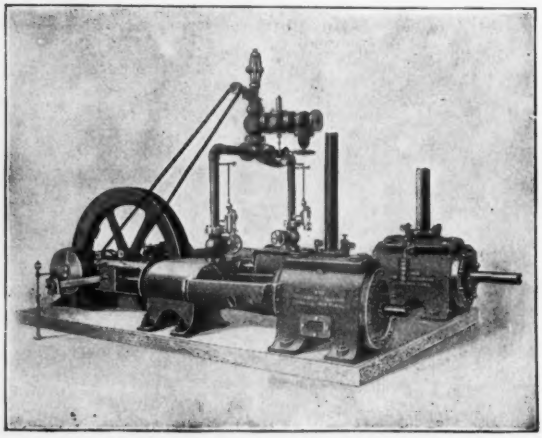

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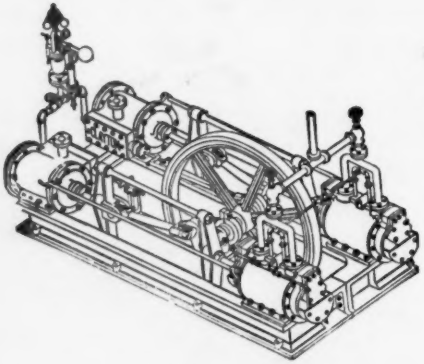

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